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(54) **Withstand-voltage testing method and apparatus.**

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Description

The present invention relates to a method of testing a withstand-voltage of a device or work including a core conductor coated for insulation and a withstand-voltage testing apparatus employed in this method.

Figs. 1 to 3 show a known high withstand-voltage testing apparatus for testing a high withstand-voltage of a device or work 1 in which a core conductor 2 is coated for insulation with an insulating member 3 made of resin, etc. For the test, the device 1 is enclosed by a grounded conductor 4. A three-pole discharge electrode 5 is constituted by a positive pole 5a, a negative pole 5b and a floating pole 5c. The positive pole 5a is connected to the core conductor 2, while the negative pole 5b is connected to the grounded conductor 4. A high-voltage pulse generator 6 is constituted by a high-voltage generator 6a and an oscillator 6b. A resistor R for detecting leakage current of the device 1 is inserted between the grounded conductor 4 and earth. A voltmeter 7 is provided for detecting voltage of the resistor R.

As shown in Fig. 3, disclosing the most relevant prior art, in the case where a high-voltage cable 9 coupled with a spark plug 8 for automobiles is employed as the device 1, a resinous coating 10 of the high-voltage cable 9 has joints and pin holes. Thus, a high withstand-voltage test is performed mainly at coupling portions 10a and 10b of the high-voltage cable 9, where leakage current is likely to be produced. Accordingly, a distal end 8′ of the high-voltage cable 9 adjacent to the spark plug 8 is supported by a coupling jig 11c.

Meanwhile, after a conductor 12 extending from the coupling portion 10a has been insulated by resin 13 or the like, the coupling portions 10a and 10b are supported by grounding jigs 11a and 11b, respectively and further are, respectively, surrounded by metallic beads 4a and 4b strung on threads and acting as the grounded conductor 4 so as to be grounded.

In the above described arrangement of the known high withstand-voltage testing apparatus, high-voltage pulses are applied to the core conductor 2 and the positive pole 5a of the discharge electrode 5 as shown in Fig. 1. When there is no leakage current in the device 1, a pulsed discharge beam signal are continuously generated in a gap of the discharge electrode 5. On the contrary, when there is leakage current in the device 1, discharge does not take place at the discharge electrode 5 and electric current flows through the resistor R. In this case, by reading voltage of the voltmeter 7, it is decited that the device 1 has improper withstand-voltage. It is to be noted that the voltmeter 7 may be replaced by a neon lamp, etc.

In the known high withstand-voltage testing apparatus referred to above, leakage current in the device 1 is detected by the resistor R or the neon lamp. The resistor R or the neon lamp is an electric detector and therefore, is affected by electrical noises. Accordingly, if electrical noises become extremely large, it is necessary to raise impedance between the detection system and the decision system. As a result, such a drawback is incurred that the decision system is susceptible to electrical noises and thus, functions unstably.

For example, such a phenomenon may happen in the known apparatus that even in the case where the device 1 has proper withstand-voltage and a pulsed discharge beam signal is generated at the discharge electrode 5, leakage current due to moisture, etc. is detected at the device 1, thereby resulting in erroneous decision in the high withstand-voltage test. Furthermore, the known high withstand-voltage testing apparatus has been disadvantageous in that erroneous decision is likely to be made due to long response time from detection to decision or drop of detection sensitivity.

DE-A-2 851 537 discloses a protection circuit with a spark gap and a protective resistor. If an overcurrent flows from the power source, a spark is generated and light of the spark is received by a photosensor. The light of the spark is amplified and converted into current by an amplifier and is transmitted to a contact-breaking device so that the circuit is turned off.

An essential object of the present invention is to provide a method of and an apparatus for testing a withstand-voltage of a device having a core conductor coated for insulation, which eliminate the disadvantages inherent in conventional methods and apparatuses of this kind. This object is solved with the features of Claims 1 and 2, respectively.

In accordance with the present invention, generation of leakage current of the device is detected by directly detecting presence or absence of the pulsed discharge beam signal generated at the gap of the discharge electrodes, whereby it becomes possible to judge whether or not the device has proper dielectric strength.

This object and features of the present invention will become apparent from the following description taken in conjunction with the preferred embodiment thereof with reference to the accompanying drawings, in which:

Fig. 1 is a block diagram of a prior art withstand-voltage testing apparatus (already referred to);

Fig. 2 is a top plan view of a device employed in the prior art withstand-voltage testing apparatus of Fig. 1 (already referred to);

Fig. 3 is a fragmentary side elevational view of a high-voltage cable of a spark plug for automobiles, which is employed as the device of Fig. 2 (already referred to); and

Fig. 4 is a block diagram of a withstand-voltage testing apparatus according to one embodiment

of the present invention.

Before the description of the present invention proceeds, it is to be noted that like parts are designated by like reference numerals throughout several views of the accompanying drawings.

Hereinbelow, a withstand-voltage testing method and a withstand-voltage testing apparatus K employed in this method, according to one embodiment of the present invention are described with reference to Fig. 4.

In the same manner as in the prior art apparatus of Figs. 1 to 3, a device 1 has a core conductor 2 which is coated for insulation with an insulating member 3 made of resin, etc. For the test, the device 1 is enclosed by a grounded conductor 4. A high-voltage pulse generator 6 is constituted by a high-voltage generator 6a and an oscillator 6b.

However, in the apparatus K (Fig. 4), the discharge electrode 5 of the prior art apparatus is replaced by a discharge electrode 15 constituted by a positive pole 15a, a negative pole 15b and a floating pole 15c. The positive pole 15a is connected to the core conductor 2, while the negative pole 15b is connected to the grounded conductor 4. The apparatus K further includes a light receiving portion 16 and a decision portion 17. In order to detect leakage current of the device 1 in the apparatus K, an optical detecting system including the discharge electrode 15, the light receiving portion 16 and the decision portion 17 is employed in place of the prior art electric detecting system (Figs. 1 and 2) including the resistor R, the voltmeter 7, etc.

The light receiving portion 16 includes an optical fiber 16a drawn from vicinity of a gap of the discharge electrode 15 and a high-speed photo diode 16b. The photo diode 16b is connected to an output of the optical fiber 16a so as to generate a reverse voltage upon reception of light.

Meanwhile, the decision portion 17 includes a synchronous comparator 17a and a judging portion 17b. The synchronous comparator 17a is connected to an output of the photo diode 16b so as to synchronously compare high-voltage pulses applied to the discharge electrode 15 and a pulsed electrical signal derived from the pulsed discharge beam signal a. The judging portion 17b is connected to an output of the synchronous comparator 17a and detects presence or absence of leakage current in the device 1 by detecting presence or absence of the pulsed discharge beam signal a synchronous with the high-voltage pulses so as to judge whether or not the device 1 has proper withstand-voltage.

By the above described arrangement of the apparatus K, operation of the method and the apparatus K of the present invention is described. In the method of the present invention, high-voltage pulses are initially applied to the core conductor 2 of the device 1 and the positive pole 15a of the discharge electrode 15. Then, if there is no leakage current in the insulating member 3 made of resin, etc., pulsed discharge beam signal a is continuously generated in a gap of the discharge electrode 15 synchronously with the high-voltage pulses. On the other hand, if there is leakage current in the insulating member 3, a large quantity of electric current flows through the device 1 and thus, the pulsed discharge beam signal a disappears from the gap of the discharge electrode 15. Thus, presence or absence of the pulsed discharge beam signal a generated in the gap of the discharge electrode 15 is detected synchronously with the high-voltage pulses so as to detect presence or absence of leakage current of the device 1 such that a decision is made as to whether or not the device 1 has proper withstand-voltage.

When the withstand-voltage testing method of the present invention is carried out, high-voltage pulses of 50-100 Hz and about 25 kV are initially generated by the high-voltage pulse generator 6 so as to produce pulsed discharge beam signal a in the gap of the discharge electrode 15. Then, only pulse beams of the discharge beam signal a are received by the optical fiber 16a so as to be electrically converted into pulse waves b by the photo diode 16b such that the pulse waves b are outputted from the light receiving portion 16. Subsequently, the pulse waves b are detected synchronously with the high-voltage pulses by the decision portion 17. If there is no leakage current in the device 1, the pulse waves b are continuously generated. Thus, in this case, the decision portion 17 judges that the device 1 has proper withstand-voltage. On the other hand, if there is leakage current in the device 1, a large quantity of electric current flows through the device 1 at the moment and thus, the pulse waves b disappear. Therefore, when the pulse waves b disappear for one period of the pulse waves b, the decision portion 17 is capable of judging that the device 1 has improper withstand-voltage. Accordingly, the decision portion 17 has high decision accuracy. For decision accuracy in practical use, the decision portion 17 is required to judge that the device 1 has improper withstand-voltage when two or more of the pulse waves b have disappeared continuously. Meanwhile, the light receiving portion 16 desirably includes the high-speed photo diode 16b. However, the high-speed photo diode 16b may be replaced by a photo detector having a short response time.

As is clear from the foregoing description, when a withstand-voltage of a high-voltage cable having a conductor coated for insulation is tested in the present invention, the discharge beam signal generated at the discharge electrode is directly detected such that leakage current is detected based on presence or absence of generation of the discharge beam signal, whereby it is judged whether or not the high-voltage cable has proper withstand-voltage. Therefore, in accordance with the present invention, the electrically

independent optical system detects leakage current of the device and therefore, is not affected by electrical noises, thus, resulting in improvement of decision accuracy of the withstand-voltage test.

Claims

1. A method of testing a withstand-voltage of a device (1) having a core conductor (2) coated for insulation with an insulating member (3) enclosed by a grounded conductor (4); further having a first discharge electrode (15a) and a second discharge electrode (15b) spaced apart from each other by a gap and connected to the core conductor (2) and the grounded conductor (4), respectively; wherein
high-voltage pulses are applied to the discharge electrodes (15a, 15b) for generating a pulsed discharge beam signal (a) to be detected in the gap between the first and second discharge electrodes (15a, 15b); said discharge beam signal enabling the judgement whether or not the insulating member (3) has a proper withstand-voltage; characterized by
a) converting the pulsed discharge beam signal (a) by a light receiving portion (16) into a corresponding pulsed electrical signal (b);
b) synchronous comparison between the pulsed electrical signal (b) and the high-voltage pulses to detect presence or absence of leakage current of the device (1) on the basis of said synchronous comparison.

2. An apparatus (K) for testing a withstand-voltage of a device (1) having a core conductor (2) coated for insulation with an insulating member (3) which is enclosed by a grounded conductor (4), the apparatus (K) comprising a first discharge electrode (15a) and a second discharge electrode (15b) spaced apart from each other by a gap and connected to the core conductor (2) and the grounded conductor (4), respectively;
a high-voltage pulse generator (6) for applying high-voltage pulses to the discharge electrodes (15a, 15b); the apparatus being characterized by a light receiving portion (16) for detecting a pulsed discharge beam signal (a) generated in the gap between the discharge electrodes (15a, 15b) and converting the pulsed discharge beam signal (a) into a corresponding pulsed electrical signal (b);
a decision portion (17) with a synchronous comparator (17a) and a judging portion (17b) for synchronous comparison of the pulsed electrical signal (b) with the high-voltage pulses and for judging whether or not the device (1) has a proper dielectric strength on the basis of the result of the synchronous comparison.

3. The apparatus (K) as claimed in claim 2, wherein the light receiving portion (16) includes an optical fiber (16a) and a high-speed photo diode (16b).

Patentansprüche

1. Verfahren zur Prüfung einer Stehspannung eines Bauelements (1) mit einer Leiterader (2), die zur Isolierung mit einem Isolierelement (3) beschichtet ist, das von einem geerdeten Leiter (4) umschlossen wird; mit einer ersten Entladungselektrode (15a) und einer zweiten Entladungselektrode (15b), die durch einen Spalt voneinander beabstandet und mit der Leiterader (2) bzw. dem geerdeten Leiter (4) verbunden sind; wobei
an die Entladungselektroden (15a, 15b) Hochspannungsimpulse zur Erzeugung eines in dem Spalt zwischen der ersten und der zweiten Entladungselektrode (15a, 15b) nachzuweisenden Impulsentladungsstrahlsignals (a) angelegt werden; wobei das Entladungsstrahlsignal eine Beurteilung ermöglicht, ob das Isolierelement (3) eine geeignete Stehspannung aufweist oder nicht; gekennzeichnet durch
a) Umwandlung des Impulsentladungsstrahlsignals (a) durch einen Lichtempfangsteil (16) in ein entsprechendes elektrisches Impulssignal (b);
b) Synchronvergleich zwischen dem elektrischen Impulssignal (b) und den Hochspannungsimpulsen zum Nachweis des Vorhandenseins oder Fehlens eines Leckstroms des Bauelements (1) auf der Basis des Synchronvergleichs.

2. Vorrichtung (K) zum Prüfen einer Stehspannung eines Bauelements (1) mit einer Leiterader (2), die zur Isolierung mit einem Isolierelement (3) beschichtet ist, das von einem geerdeten Leiter (4) umschlossen wird, wobei die Vorrichtung (K) aufweist: eine erste Entladungselektrode (15a) und eine zweite Entladungselektrode (15b), die durch einen Spalt voneinander beabstandet und mit der Leiterader (2) bzw. dem geerdeten Leiter (4) verbunden sind;
einen Hochspannungsimpulsgenerator (6) zum Anlegen von Hochspannungsimpulsen an die Entladungselektroden (15a, 15b);
wobei die Vorrichtung gekennzeichnet ist durch
einen Lichtempfangsteil (16) zur Erfassung eines Impulsentladungsstrahlsignals (a), das in dem Spalt zwischen den Entladungselektroden (15a, 15b) erzeugt wird, und zur Umwandlung des Impulsentladungsstrahlsignals (a) in ein

entsprechendes elektrisches Impulssignal (b);

einen Entscheidungsteil (17) mit einem Synchronkomparator (17a) und einem Beurteilungsteil (17b) für einen Synchronvergleich des elektrischen Impulssignals (b) mit den Hochspannungsimpulsen sowie zur Beurteilung anhand des Ergebnisses des Synchronvergleichs, ob das Bauelement (1) eine geeignete Durchschlagsfestigkeit aufweist oder nicht.

3. Vorrichtung (K) nach Anspruch 2, wobei der Lichtempfangsteil (16) einen Lichtwellenleiter (16a) und eine Hochgeschwindigkeits-Fotodiode (16b) aufweist.

Revendications

1. Procédé de test d'une tension de tenue d'un dispositif (1) ayant un conducteur d'âme (2) enduit pour l'isolation avec un élément d'isolation (3) entouré par un conducteur de masse (4) ; ayant en outre une première électrode de décharge (15a) et une seconde électrode de décharge (15b) séparées l'une de l'autre par un écartement et respectivement reliées au conducteur d'âme (2) et au conducteur de masse (4) ; dans lequel

des impulsions haute-tension sont appliquées aux électrodes de décharge (15a, 15b) pour générer un signal de faisceau de décharge pulsé (a) à détecter dans l'écartement entre les première et seconde électrodes de décharge (15a, 15b) ; ledit signal de faisceau de décharge permettant de tester si oui ou non l'élément d'isolation (3) a une tension de tenue appropriée ; caractérisé par une

a) conversion du faisceau de décharge pulsé (a) par une partie de réception de lumière (16) en un signal électrique pulsé correspondant (b) ;

b) comparaison synchrone entre le signal électrique pulsé (b) et les impulsions haute-tension pour détecter la présence ou l'absence d'un courant de fuite du dispositif (1) sur la base de ladite comparaison synchrone.

2. Appareil (K) pour tester une tension de tenue d'un dispositif (1) ayant un conducteur d'âme (2) enduit à des fins d'isolation avec un élément d'isolation (3) qui est entouré par un conducteur de masse (4), l'appareil (K) comprenant une première électrode de décharge (15a) et une seconde électrode de décharge (15b) séparées l'une de l'autre par un écartement et respectivement reliées à un conducteur d'âme (2) et au conducteur de masse (4) ;

un générateur d'impulsions haute-tension (6) pour appliquer des impulsions haute-tension aux électrodes de décharge (15a, 15b) ; l'appareil étant caractérisé par

une partie de réception de lumière (16) pour détecter un signal de faisceau de décharge pulsé (a) généré dans l'écartement entre les électrodes de décharge (15a, 15b) et pour convertir le signal de faisceau de décharge pulsé (a) en un signal électrique pulsé correspondant (b) ;

une partie de décision (17) ayant un comparateur synchrone (17a) et une partie de test (17b) pour une comparaison synchrone du signal électrique pulsé (b) avec les impulsions haute-tension et pour tester si oui ou non le dispositif (1) a une résistance diélectrique appropriée sur la base du résultat de la comparaison synchrone.

3. Appareil (K) selon la revendication 2, dans lequel la partie de réception de lumière (16) comprend une fibre optique (16a) et une photodiode de vitesse élevée (16b).

Fig. 1 PRIOR ART

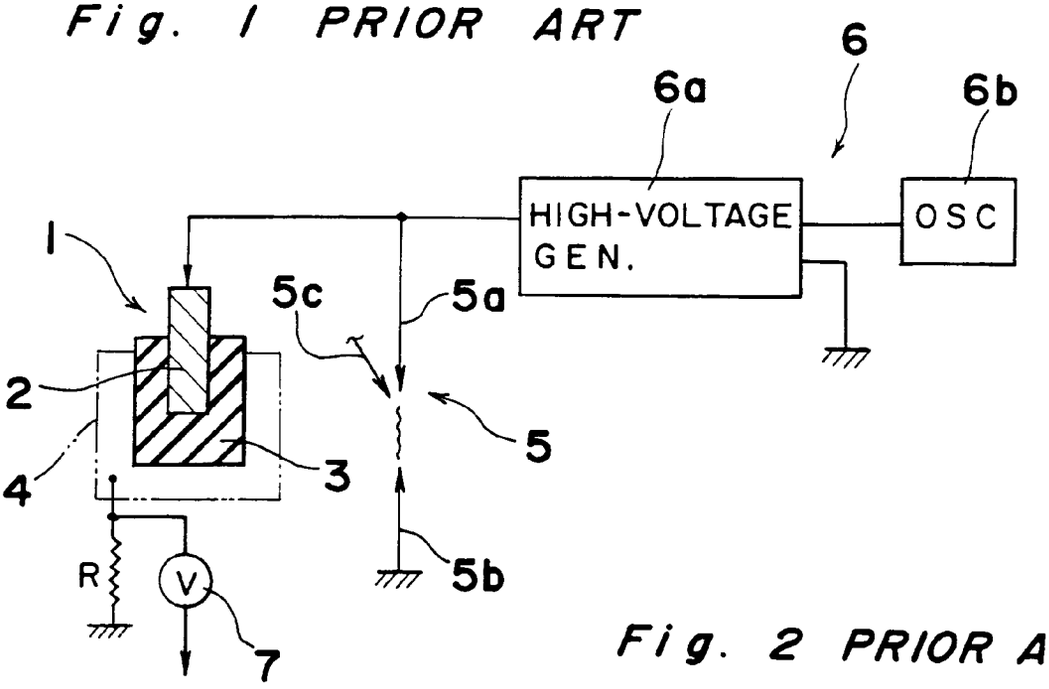


Fig. 2 PRIOR ART

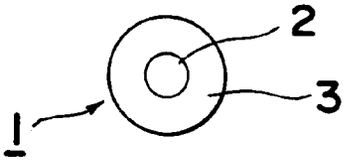


Fig. 3 PRIOR ART

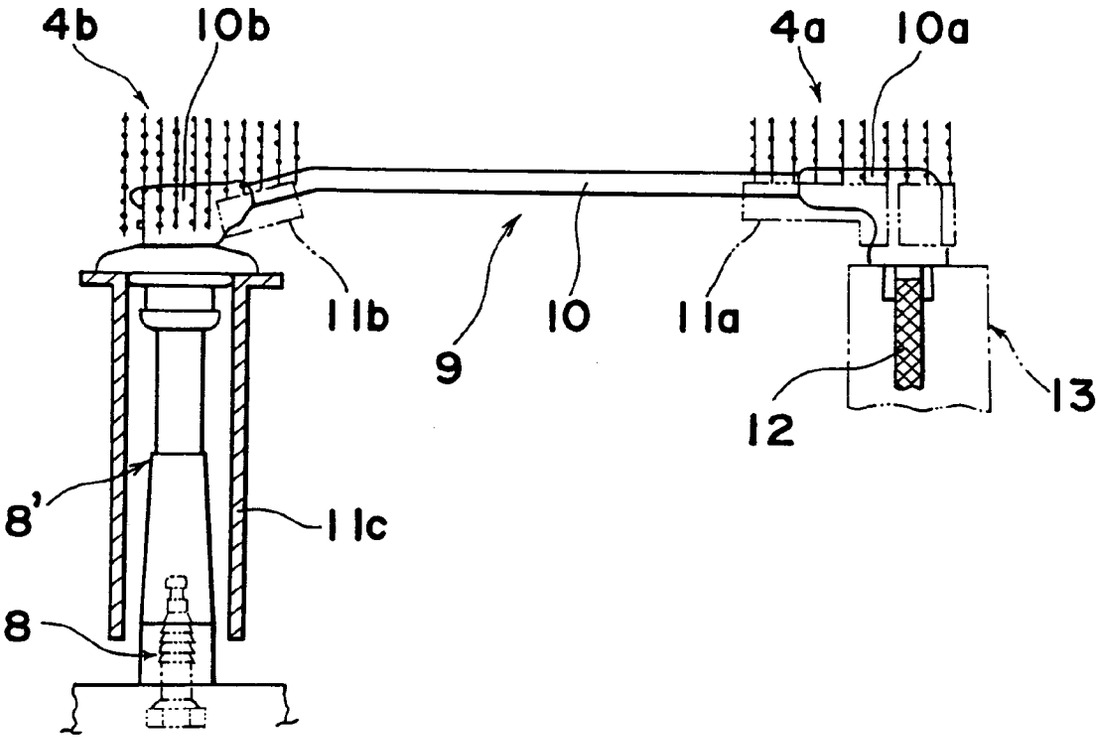
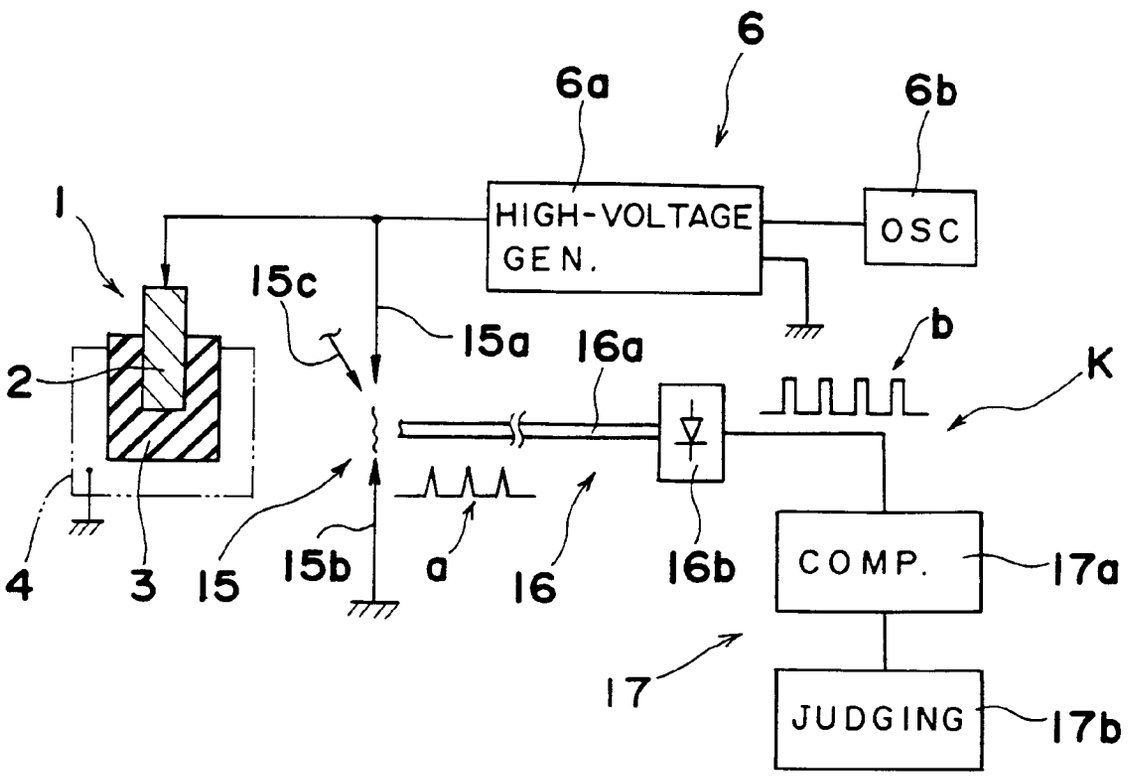


Fig. 4


6
6a
6b
HIGH-VOLTAGE GEN.
OSC
1
15c
15a
16a
b
K
2
4
3
15
15b
a
16
16b
COMP.
17a
17
JUDGING
17b